CALIFORNIA
AIR RESOURCES BOARD

Advanced Clean Fleets Regulation Workshop

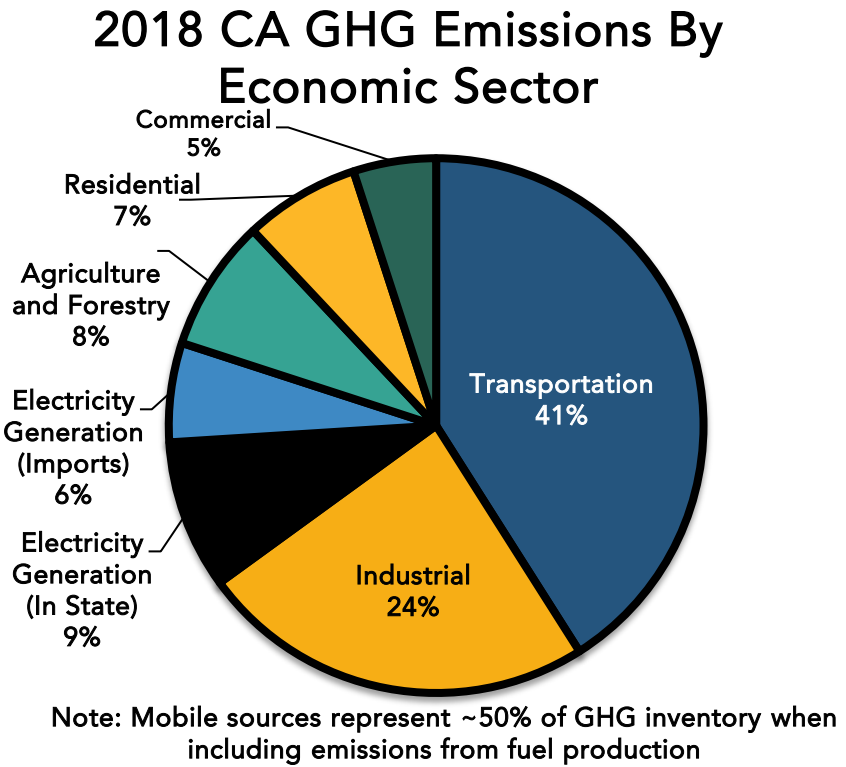
September 9, 2021

Today's Outline

- Introduction
- Zero-emission vehicle (ZEV) market
- Fleet regulation proposal
  - Public Fleets
  - Drayage Fleets
  - High Priority and Federal Fleets
- Cost analysis

Greenhouse Gas (GHGs) Goals

- California's climate change targets
  - 40% below 1990 levels by 2030
  - 80% below 1990 levels by 2050
  - Carbon neutrality by 2045
- Clean electricity
  - 33% renewable by 2020
  - 60% renewable by 2030
  - Zero-carbon by 2045



Note: Mobile sources represent ~50% of GHG inventory when including emissions from fuel production

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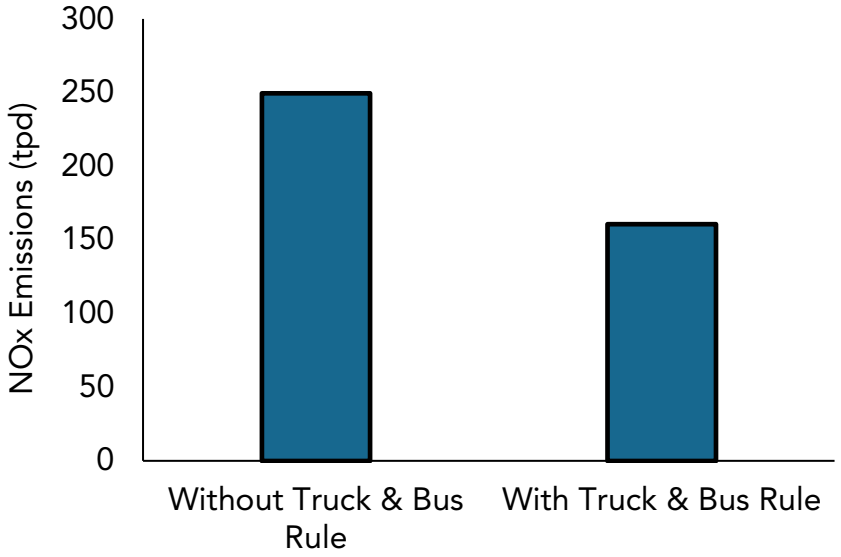
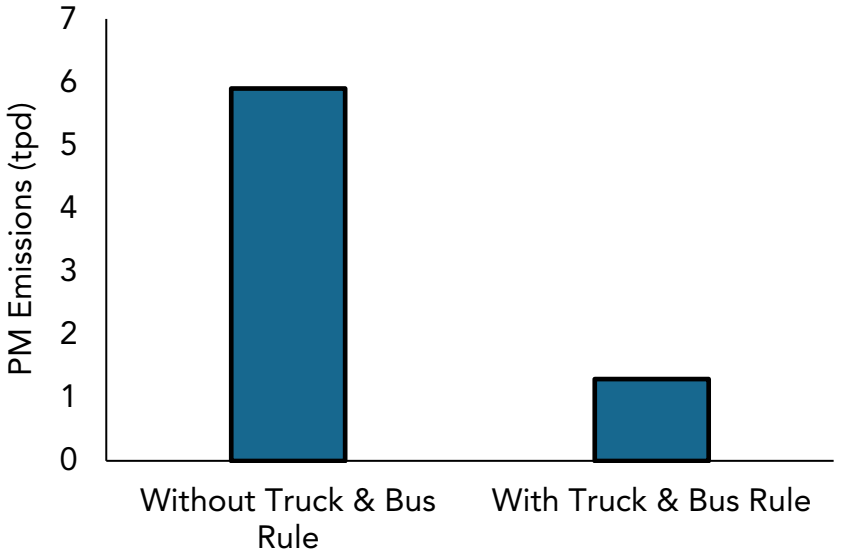
Source: California GHG Inventory (https://ww2.arb.ca.gov/ghg-inventory-data)

Truck and Bus Emissions Reduction

Statewide NOx Emissions from Heavy Duty Vehicles (>14,000 lbs.) in 2023



Statewide PM Emissions from Heavy Duty Vehicles (>14,000 lbs.) in 2023



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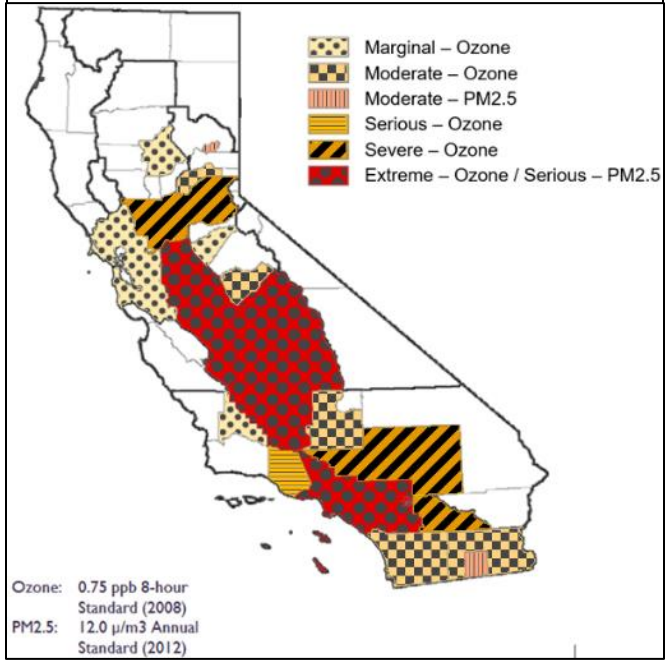
Major Oxides of Nitrogen (NOx) and Fine Particulate Matter ($PM_{2.5}$) Emissions Reductions Needed

- California has the worst air quality in the nation
- Unique challenges in San Joaquin Valley and South Coast
- Heavy-duty trucks and federal sources* remain largest contributors
- Action beyond current programs needed to meet 2031 South Coast attainment goal
  - Nearly all heavy trucks to have 2010 model year engines by 2023

California Ozone and $PM_{2.5}$ Non-Attainment Areas



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*Planes, trains, ships

Disadvantaged Community Objectives

- Assembly Bill (AB) 617 directs CARB to identify community level strategies
- Communities seek action on transportation and freight emissions
- Seek rapid transition to zero-emissions

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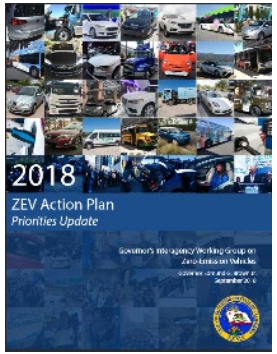
California Leading the Way for a Sustainable Future

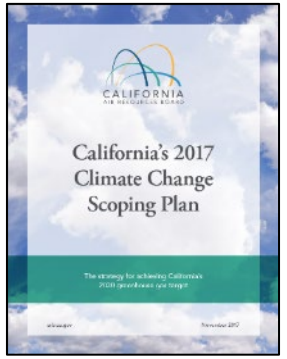
Governor Executive Order N-79-20

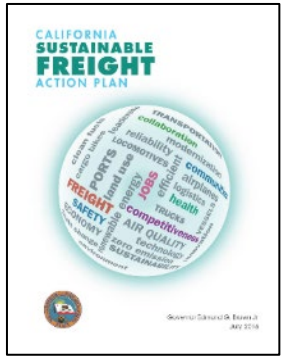
100% ZEV sales by 2035

Full transition to
ZEV short-haul/drayage trucks
by 2035

Full transition to **ZEV buses** &
heavy-duty long-haul trucks
by 2045*







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Pillars of the ZEV Market

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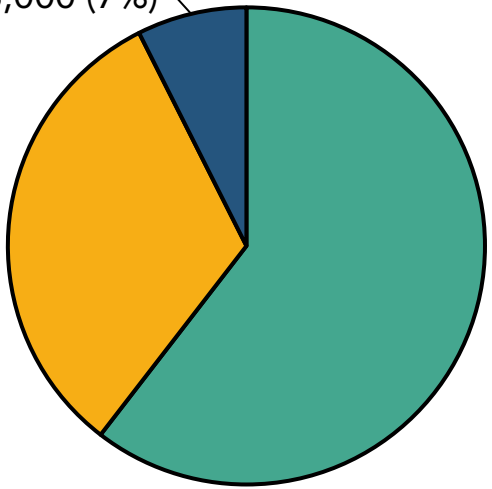
ZEV Targets

- Meet Board resolution for the ACT regulation and set 100% ZEV fleet targets
  - 2035 – Last mile delivery, drayage, public fleets
  - 2040 – Refuse, utilities, buses
  - 2045 – All other trucks where feasible
- Meet Governor's Executive Order 100% ZEV goals
  - 2035 for drayage trucks
  - 2045 for all other trucks and buses, where feasible

California Truck Populations



Source: California Air Resources Board (CARB) Emissions Inventory (EMFAC) (https://arb.ca.gov/emfac/) - 2021 Calendar Year, includes California International Registration Plan (IRP), excludes out-of-state IRP trucks, motor homes, transit buses, and school buses. (https://arb.ca.gov/emfac/)

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Advanced Clean Trucks (ACT)

- Manufacturer ZEVs as a percentage of annual sales*
- Approved June 2020
- Begins with 2024 model year
- Credit for sales start in 2021
- Minimum tractor sales
- Flexibility to shift sales between categories

Model Year (MY)	Class 2b-3	Class 4-8	Class 7-8 Tractors
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035+	55%	75%	40%

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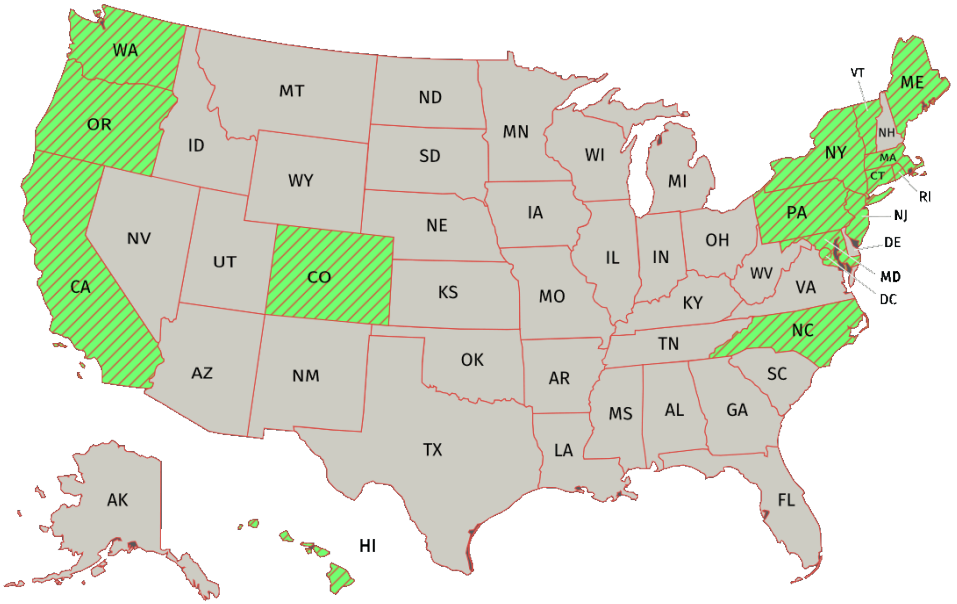
*Partial credit for near-zero emissions vehicles (NZEVs). NZEVs are plug-in hybrids with minimum all electric range

Multistate ZEV Truck Targets

- 15 states and the District of Columbia signed a memorandum of understanding (MOU) supporting rapid expansion of ZEV truck market
- Sets ZEV sales targets
  - 30% sales by 2030
  - 100% sales by 2050
- Develop truck ZEV action plans



[Multi-state ZEV truck Memorandum of Understanding](https://www.nescaum.org/documents/multistate-truck-zev-governors-mou-20200714.pdf)
(https://www.nescaum.org/documents/multistate-truck-zev-governors-mou-20200714.pdf)

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Zero-Emission Vehicle Market Overview

ZE Truck and Bus Market

- Wide variety of ZEVs available
  - New and start-up manufacturers lead the way
  - Major manufacturers entering market
  - Major parts suppliers introducing commercial components
- Continued improvements expected
  - Technology advancement
  - Continued incremental cost reductions
  - Infrastructure build-out

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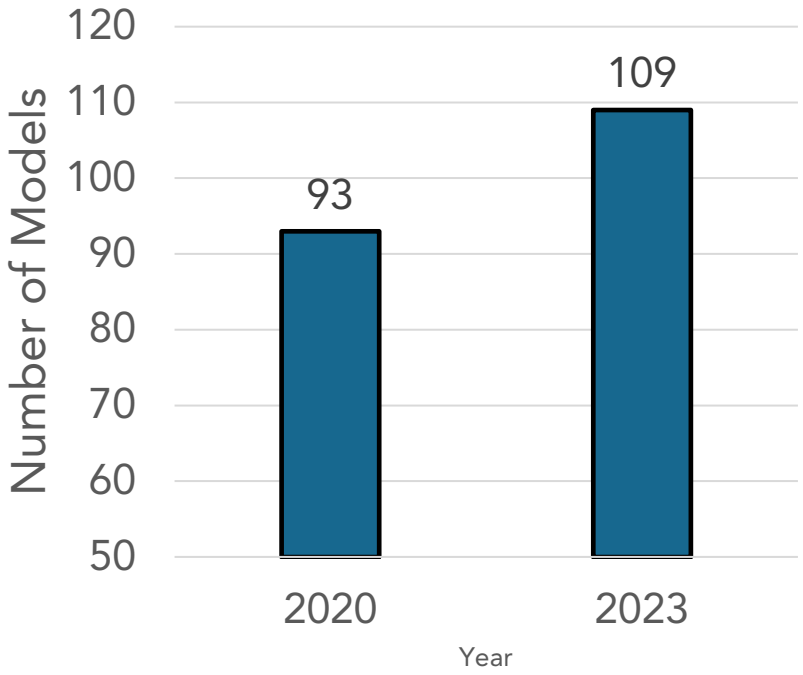
ZEV Straight Truck Model Availability



Source: CalStart Zero Emission Technology Inventory (https://globaldrivetozero.org/tools/zero-emission-technology-inventory/)

ZEV Tractor Commercial Availability

Available Today

- BYD 8TT
- Lion Electric LION8
- Kenworth T680E
- Volvo VNR Electric

- Hyundai XCIENT
- Freightliner eCascadia

- Nikola One/Two
- Tesla Semi

2022

2023

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Source: CalStart Zero Emission Technology Inventory (https://globaldrivetozero.org/tools/zero-emission-technology-inventory/)

Infrastructure Coordination

- State agency coordination on ZEV infrastructure goals
- Private Investment Opportunities
- Governor's Office of Business and Economic Development (Go-BIZ)
  - Coordinating infrastructure support
  - Lead agency for the ZEV Market Development Strategy
  - Streamlining ZEV infrastructure development
  - Electric Vehicle Charging Station Permitting Guidebook
  - Hydrogen Station Permitting Guidebook
  - ZEV Permitting Olympics

Infrastructure Coordination

- California Energy Commission
  - Biennial statewide charging infrastructure assessment (AB 2127)
  - Spatially model future infrastructure and energy demand
  - Funding
    - EnergIIZE benefits disadvantage communities
      - $50M multi-year project for MHD ZE buses and trucks
    - Emission Drayage Truck and Infrastructure Pilot Project
      - Solicitation-up to $20M from each agency
- Total funding include for infrastructure in the current budget
  - $390M for 1,000 zero emission drayage trucks, 1,000 zero-emission transit buses, and 1,000 zero-emission school buses
  - $25M for drayage pilot
  - $500M for general ZEV infrastructure through CEC's Clean Transportation Program

Infrastructure Coordination

- California Public Utilities Commission
  - Support Senate Bill 350 and other transportation electrification goals
    - $686 million approved through 2023 for three largest utilities
    - Charging for 18,000 trucks, buses, and off-road vehicles
    - Authorized $2 Billion in investor-owned electric utilities spending on infrastructure

Infrastructure Coordination

- CalTrans
  - Handbook for implementing workplace and public ZEV infrastructure
  - Develop a Dig Smart policy in order to lower the capital cost and minimize disruptions of infrastructure deployment
  - Partner with Volkswagen subsidiary and Electrify America to maintain and operate 271 EVSEs* at Caltrans workplace locations
  - Leverage CALeVIP** rebate and Department of General Services funding for Caltrans EVSE workplace locations
- Strategic Growth Council
  - Investing into communities
  - Creating opportunities to enable ZEV adoption
  - 50% of funding projects located in disadvantaged communities
    - Funding for ZEV charging or fueling infrastructure and vehicles for low income and disadvantage communities

Caltrans

CALIFORNIA STRATEGIC GROWTH COUNCIL

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*EVSE – Electric Vehicle Supply Equipment

** CALeVIP - California Electric Vehicle Infrastructure Project

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Advanced Clean Fleets (ACF) Regulation

Regulation Timeline

- Regulation language posted August 25, 2021
- Comments requested by September 27, 2021
  - Meeting materials posted on "Meetings and Events" page on CARB's ACF webpage
  - Informal comment docket (https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=acf-comments-ws&comm_period=1)
- Board recommendation late summer/fall 2022

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Meetings and Events Page (https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-meetings-events)

Regulation Overview

- General scope summary
  - Any vehicle with a manufacturer's gross vehicle weight rating (GVWR) above 8,500 lbs.
  - Off-road yard tractors
- Proposed zero-emission requirements
  - Public fleets*
  - Drayage trucks
  - High priority and federal fleets
  - 100% ZEV sales by 2040

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* Excludes federal

Public Fleets
Section 95693

Scope and Applicability

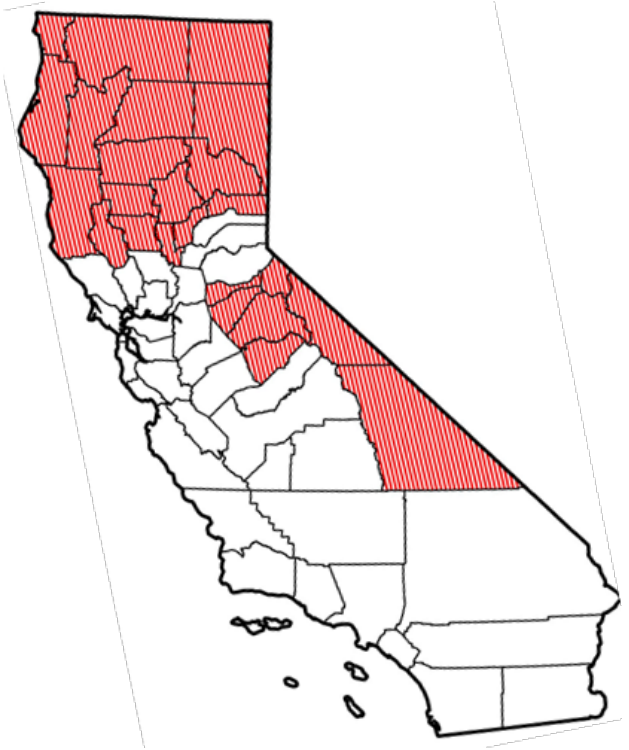
- Public agencies that own, lease, or operate a diesel-fueled heavy-duty vehicle with manufacturer's gross vehicle weight rating greater than 8,500 pounds
- City, county, public utility, special district, or an agency of the State of California, and any department, division, public corporation
- Excludes federal agencies

Exempt From Regulation

- School buses
- Military tactical vehicles
- Emergency vehicles (California Vehicle Code (CVC) 165)
- Transit vehicles subject to Innovative Clean Transit regulation
- Historical vehicles
- Dedicated snow removal vehicles

Public Fleet ZEV Purchases

- ZEV required when purchasing new vehicles
  - 50% of purchases in 2024-2026
  - 100% of purchases starting 2027
- Until 2035, may purchase NZEV if no ZEV is available
- Three-year exemption in designated counties until 2027



* Federal fleets addressed with private fleets

* Near Zero Emission Vehicle (NZEV): NZEVs are plug-in hybrids with minimum all electric range

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Emergency Response Exemption

- Applies to electricity, natural gas, water, wastewater service providers
- Exemptions limited to 25% of total fleet
- Must demonstrate:
  - >75% of body type must be ZEVs already
  - No infrastructure or mobile fueling options available
  - NZEVs not available
  - Why more ZEVs will limit ability to provide emergency service

Public Fleet Reporting

- Report fleet annually by March 1
  - Within 30 days of adding vehicles to the fleet
- General agency information
- Vehicle information
  - VIN, make, model, model year, weight class, body type
  - Fuel and drivetrain type
  - Date bid awarded, date purchase made, date vehicle received
- Records to be provided upon request
  - Registration, vehicle information, purchase documents, etc.

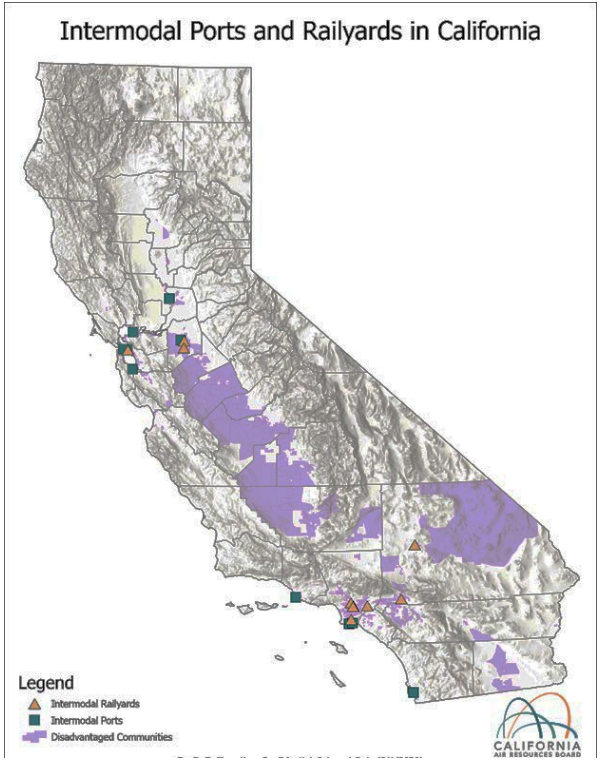
Drayage Fleets
Section 95691

Drayage Truck Proposal

- Drayage trucks are on-road, diesel-fueled, heavy-duty trucks that transport containers and bulk to and from the seaports and intermodal railyards, as well as many other locations.
- Would require all Class 7 and 8 drayage trucks operating at intermodal seaports or railyards to be full ZE by 2035

Drayage Truck Proposal Considerations

- Current drayage truck regulation sunsets in 2022
  - Trucks will have to meet 2010 MY engine standards beginning in 2023
- Impacts to disadvantaged communities
  - The intermodal seaports and railyards under the current Drayage Truck Regulation are all located in or within ~1 mile of a disadvantaged community



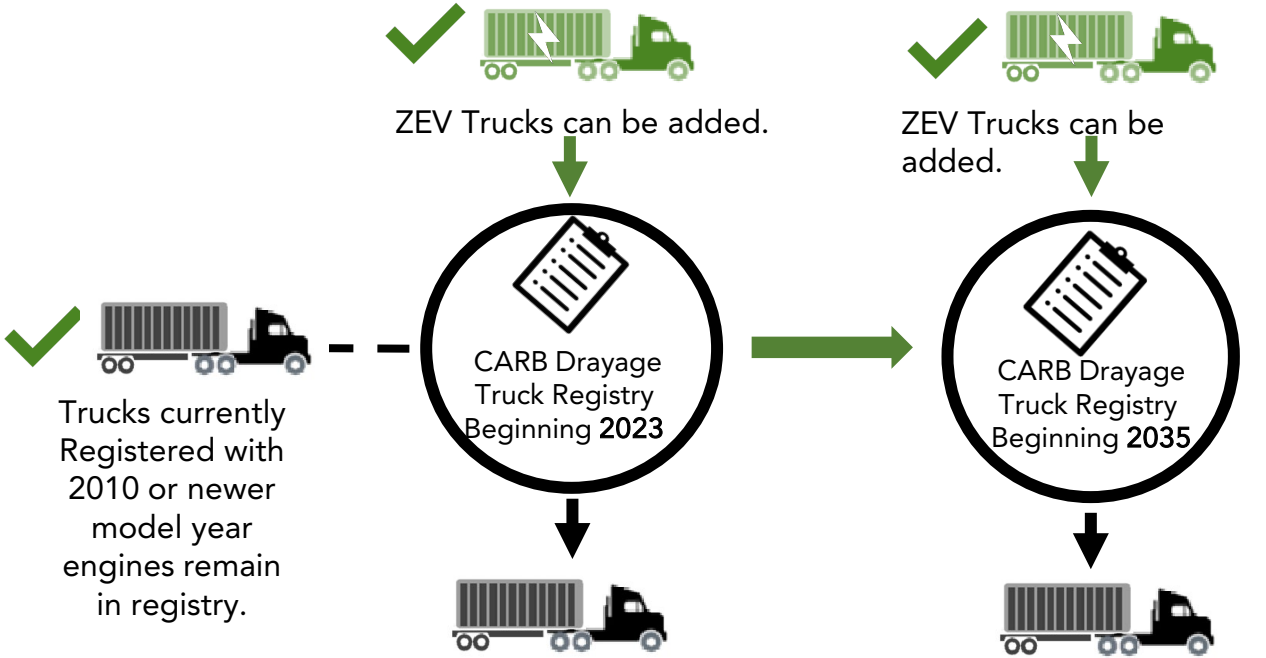
2035 Zero-Emission Drayage Transition

- Starting late-2023, only ZEVs may be added to the CARB Drayage Truck Registry
- Legacy drayage trucks can stay in registry until minimum useful life expires
- Trucks must visit a California seaport or railyard at least once a year beginning in 2024 to remain in CARB Drayage Truck Registry

Port and Rail Reporting Requirements

- Truck Reporting
  - Owner information
  - VIN, engine model year, license plate
  - Odometer reading if truck is 12 years or older
- Seaport and Railyard Reporting
  - Report truck visit information annually
    - VIN, license plate, and visit frequency
  - Late-2023 reporting will establish baseline drayage fleet

Drayage Truck ZE Fleet Transition



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Calendar Year 2019 Drayage Truck Inventory

Vehicle Category	Port of Oakland (POAK)	Port of LA/LB (POLA)	Other Seaports*	Railyards**
Instate Class 8† Active Trucks***	**4,224‡**	**13,951‡**	**1,453‡**	**8,988**
Instate Class 8† Inactive Trucks***	n/a***	2,770	n/a	n/a
Instate POAK Class 8 already in POLA†	136	n/a	n/a	n/a
Class 4-7†	22	180	n/a	n/a
Out of State†	823	854	n/a	n/a
Total	**5,205**	**17,755**	**1,453**	**8,988**

† *Non-gasoline*
‡ *T7 POLA Class 8, T7 POAK Class 8, and T7 Other Ports Class 8 in EMFAC2021*
* *Estimate based on past surveys; requesting updated information from other seaports*
** *Estimated based on information provided by Union Pacific (UP) Railroad and Burlington Northern and Santa Fe (BNSF) Railway*
*** *POLA trucks with more than 112 visits/year are considered as "active trucks". 112 visit/year was determined based on POLA monthly active truck counts. POAK did not provide monthly visit data and therefore all POAK Class 8 in-state trucks were considered active.*

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What it Means for Drayage Trucks

- Builds on the existing drayage truck registry process
- Requirements for zero-emission trucks start in late-2023
- Legacy drayage trucks registered prior to rule start continue operating as usual until odometer or age limit is exceeded
- Legacy trucks must visit a California seaport or railyard at least once a year to remain in drayage the truck registry
- Achieves all zero-emissions drayage truck fleet by 2035

High Priority and Federal Fleets Section 95692

Scope and Applicability

- Scope includes entities that:
  - Own or dispatch 50 or more vehicles under common ownership or control
  - Earned >$50 million gross annual revenue with at least 1 vehicle
  - Are federal government fleets
  - Hired affected fleets
  - Subsidiaries or fleet combinations totaling 50 or more trucks

Exempt From Regulation

- School buses
- Military tactical vehicles
- Vehicles awaiting sale
- Emergency vehicles (CVC 165)
- Transit vehicles subject to Innovative Clean Transit regulation
- Dedicated snow removal vehicles
- Vehicles subject to Mobile Cargo Handling Equipment regulation
- Historical vehicles
- Public agencies subject to 95693
- On-road vehicles subject to In-Use Off-Road Regulation
  - Two-engine trucks and workover rigs
- Heavy cranes

ZEV Phase-in Schedule

- Milestones phased-in by vehicle types
- Flexibility to meet percentage requirements with any vehicle type
- NZEVs treated the same as ZEVs until 2035

Zero-Emission Fleet Percentage	10%	25%	50%	75%	100%
Box trucks, vans, two-axle buses, yard trucks	2025	2028	2031	2033	2035
Work trucks, day cab tractors, three-axle buses	2027	2030	2033	2036	2039
Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042

Work truck means any single-unit truck that is not a box truck, van, or bus

High Priority

Mixed Fleet ZEV Phase-In Example

Vehicle Type	# of Vehicles	ZEVs in 2025	ZEVs in 2029	ZEVs in 2033	ZEVs in 2037	ZEVs in 2041	ZEVs in 2045
Box trucks, vans, two-axle buses, yard trucks 	**60**	6	15	45	60	60	60
Work trucks, day cab tractors, three-axle buses 	**20**	0	2	10	15	20	20
Sleeper cab tractors and specialty vehicles 	**20**	0	0	5	10	15	20
ZEV Milestones	**100**	**6**	**17**	**60**	**85**	**95**	**100**

Alternative Compliance Pathway

- A fleet which does not meet the ZEV milestones still complies if every vehicle which is not a ZEV or NZEV:
  - Was owned by the fleet prior to January 1, 2024 and is still within its minimum useful life, or
  - Has been granted an exemption

Compliance Verification and Recognition

- Motor carriers, brokers, and other California persons or parties may only hire compliant fleets
- Compliant fleets to be listed online
  - Fleets can print own certificate
- ZEV fleet recognition for any fleet that meets all the following:
  - Has at least one ZEV
  - ZEVs are 5 percent or more of the fleet
  - Fleet meets the applicable ZEV milestones
  - Fleet owner meets reporting and record keeping requirement

High Priority

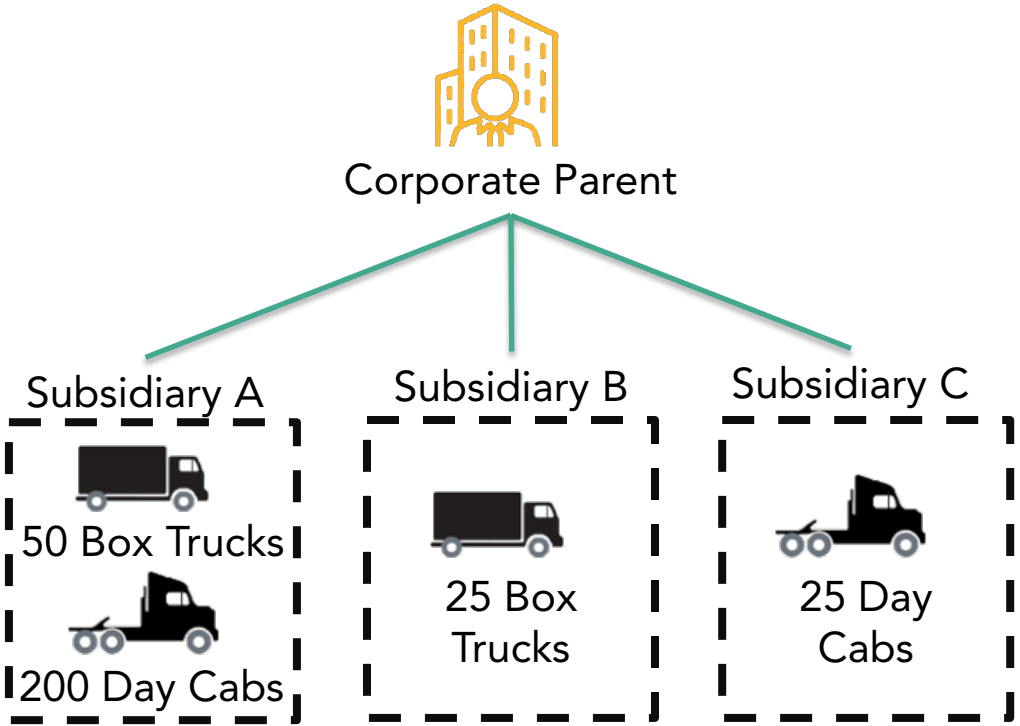
Non-Compliant Fleet Requirements

- Fleets who fail to meet the ZEV milestones or the alternative compliance pathway are subject to additional requirements
  - All vehicles added to the fleet that don't qualify for an exemption must be ZEVs
  - All vehicles which are not ZEVs which have exceeded their minimum useful life must be removed from the fleet immediately

Combination Fleet Compliance

- Corporate joint compliance
  - Subsidiaries, parent companies, joint ventures may comply independently or jointly
- Controlling party compliance
  - A controlling party must include all fleets it directs under common ownership and control as part of their own fleet

Joint Compliance Example



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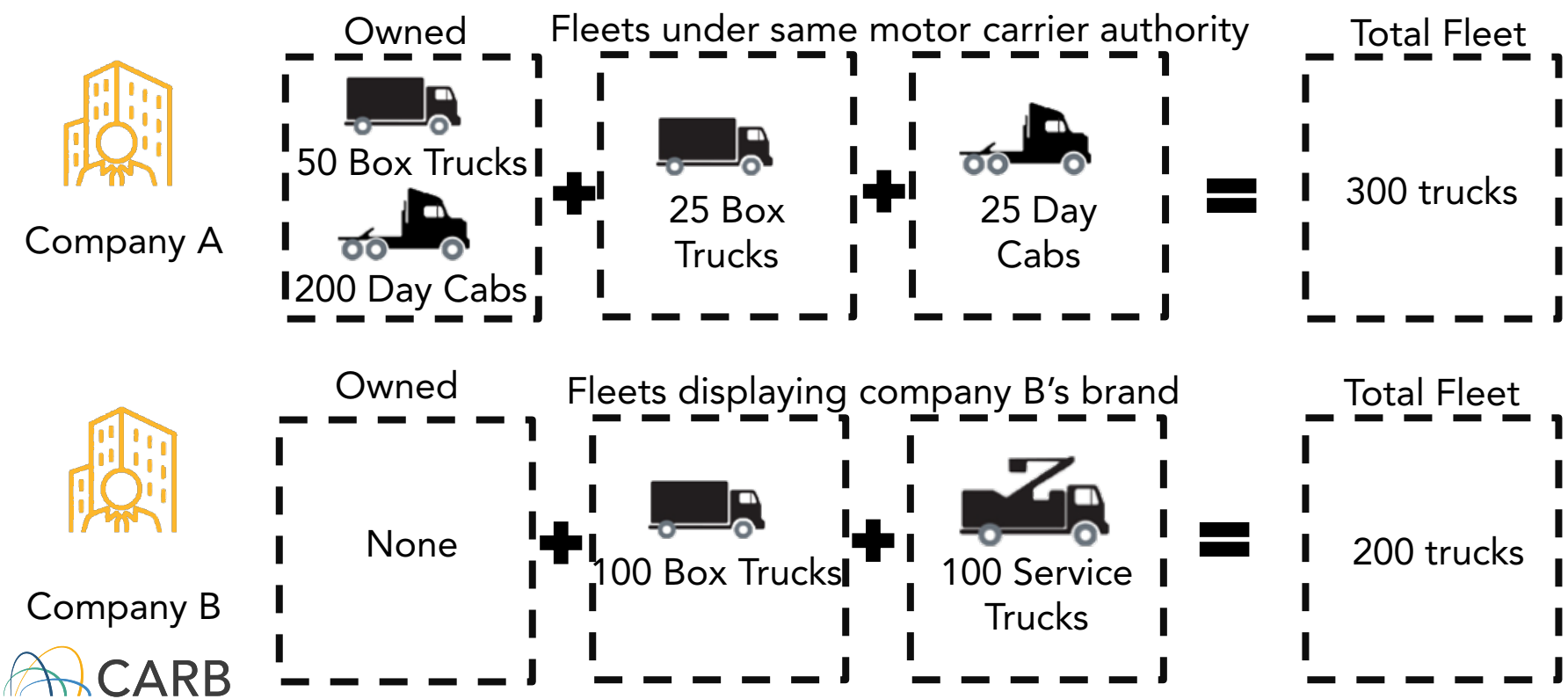
High Priority

Controlling Party Compliance Examples



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Common Ownership or Control

- Common ownership definition currently is tied to day-to-day control over vehicles in the fleet, such as:
  - Using the same motor carrier number
  - Displaying the same name or logo
  - Contractors who represent the same company
- Does not include or address:
  - Brokers dispatching loads on ad-hoc or limited term basis
  - Load-board operations

High Priority and Federal Fleet Reporting

- Report compliance annually by March 1
  - Within 30 days of adding vehicles to the fleet
- General entity information
- Vehicle information
  - VIN, make, model, model year, weight class, body type
  - Fuel and drivetrain type
  - For tractors which are 12 years or older
    - Odometer reading, engine family, and engine model year
- Records to be provided upon request
  - Registration, vehicle information, odometer readings, etc.

Backup Vehicle Exemption

- Allows backup vehicles to be excluded from milestone calculations
  - Does not apply to yard tractors
- Cannot exceed 1,000 miles per year
- Report odometer reading and miles annually to claim exemption

Daily Mileage Exemption

- If available ZEVs do not meet fleet's daily mileage needs
  - Must have 10% ZEVs in the fleet
  - Must show no NZEVs are available
  - Must show available ZEVs cannot meet daily mileage needs of any combustion powered vehicle in the fleet of that type
- Submit 30 days mileage data for each vehicle of the type requested
  - Demonstrate 3 out of 30 days needs cannot be met with ZEV
- Submit data showing no ZEV infrastructure available along routes
- Allows combustion-powered purchase instead of ZEV

High Priority

Emergency Response Exemption

- Applies to electricity, natural gas, water, wastewater services
- Addresses situations where fleets respond to emergencies
- Exemptions limited to 25% of total fleet
- Demonstrate:
  - >75% of body type must be ZEVs already
  - No infrastructure or mobile fueling options available
  - NZEVs not available
  - Why more ZEVs will limit ability to provide emergency service

Discussion Topics

- Infrastructure planning
  - How can we ensure that fleets plan ahead?
- Rule interaction with SB 1383 (2016) organic waste diversion
  - How does this interact with other State goals (Governor's Executive Order, ACT Resolution, State Implementation Plan, Mobile Source Strategy)?
  - Short-lived climate pollutants and Scoping Plan

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100 Percent ZEV by 2040
Section 95694

100% ZEV Sales Requirement

- Applies to all large and small vehicle manufacturers
- Beginning in the 2040 model year, all Class 2b-8 vehicles sold into California must be ZEV
  - Excludes authorized emergency vehicles
- Reporting – VINs, fuel and drivetrain type, documentation for sale of authorized emergency vehicles
- Recordkeeping requirements
- 100% ZEV sales provides
  - Certainty to the market and supply chain
    - Manufacturers, fleets, infrastructure providers, service technicians, sister agencies, local government
  - Expanded market choice

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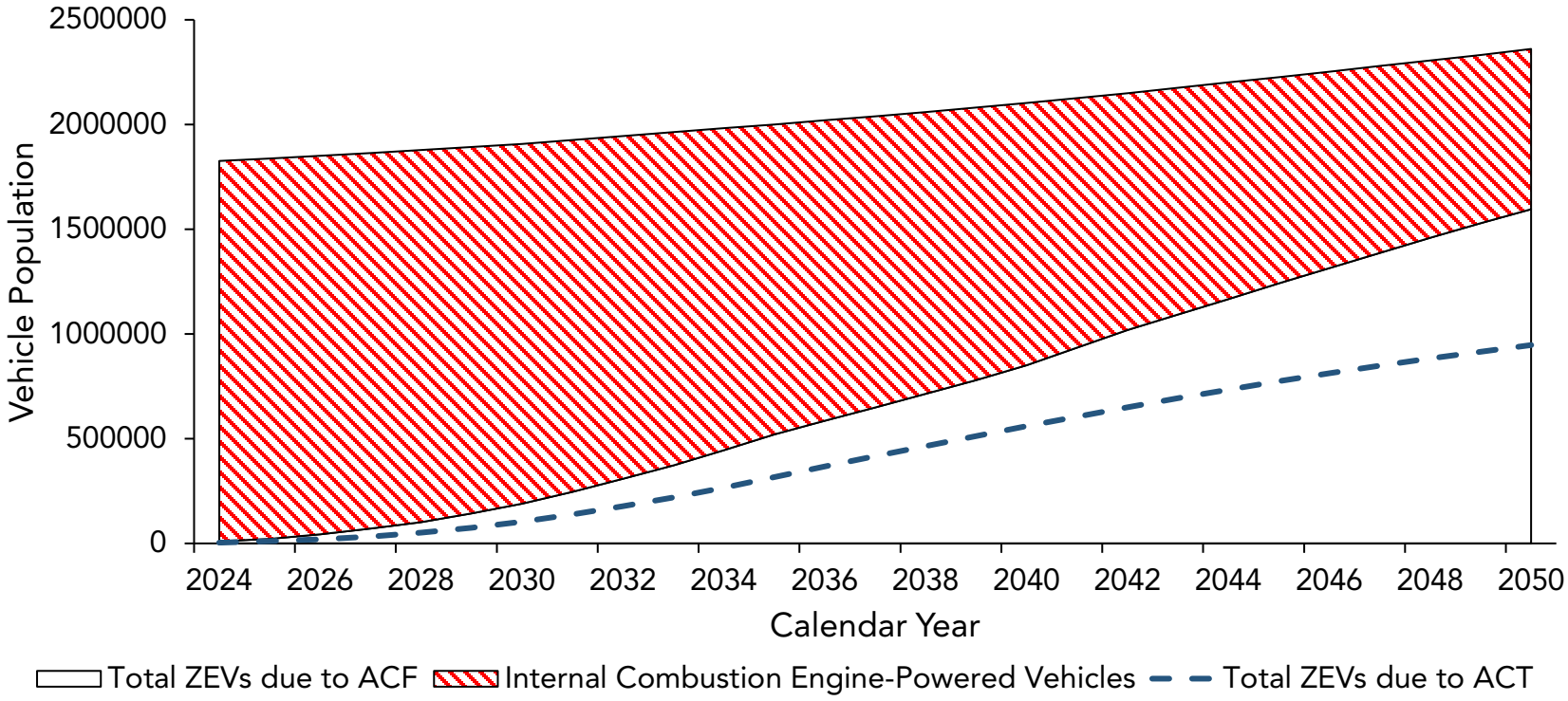
Population and Benefits

Inventory Updates

- Updated to include the rail drayage truck inventory
- Added estimates for fleets under common ownership or control based on ACT large entity one-time reporting
- Updated vehicle survival rate for public fleets
- Included 100% ZEV sales starting from 2040
- Included both ACT regulation and Heavy-Duty Omnibus regulation in the emission baseline

Projected Class 2b-8 Vehicle Population



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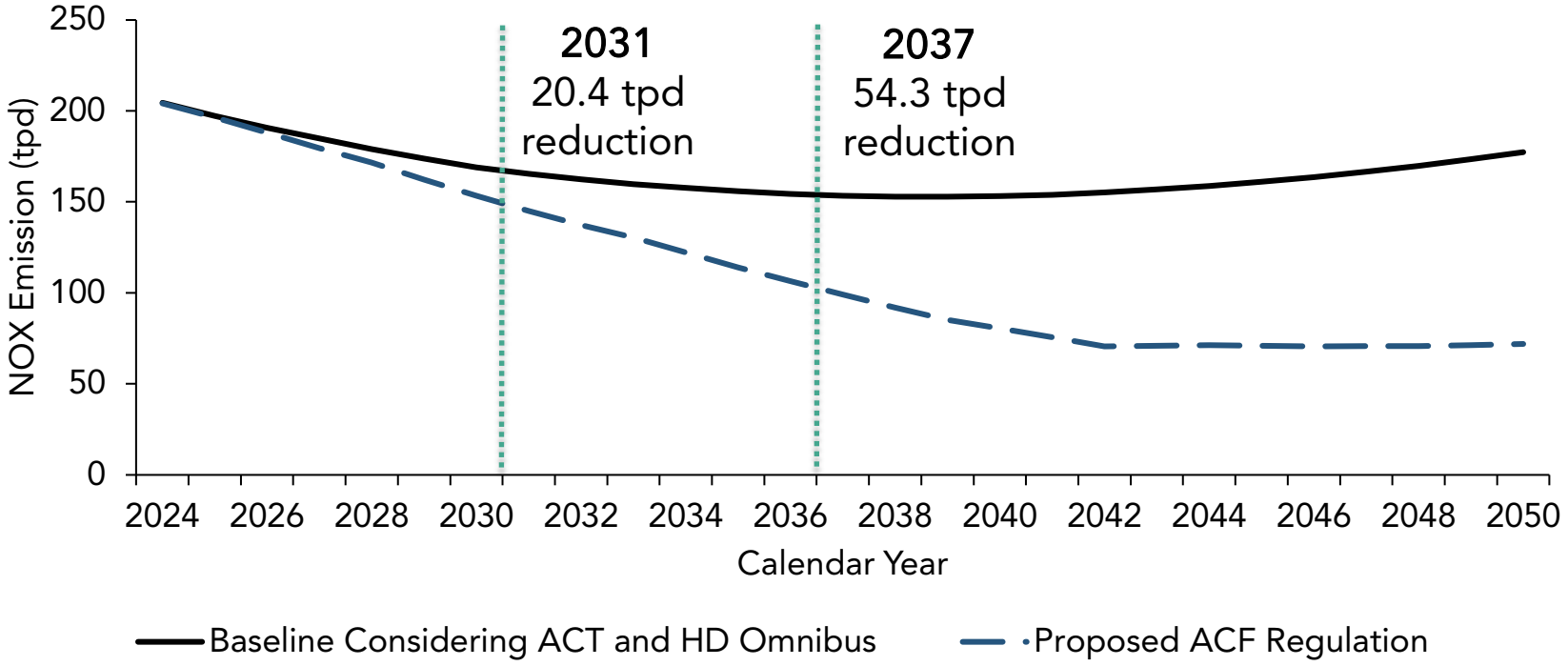
Projected Statewide NOx Emissions



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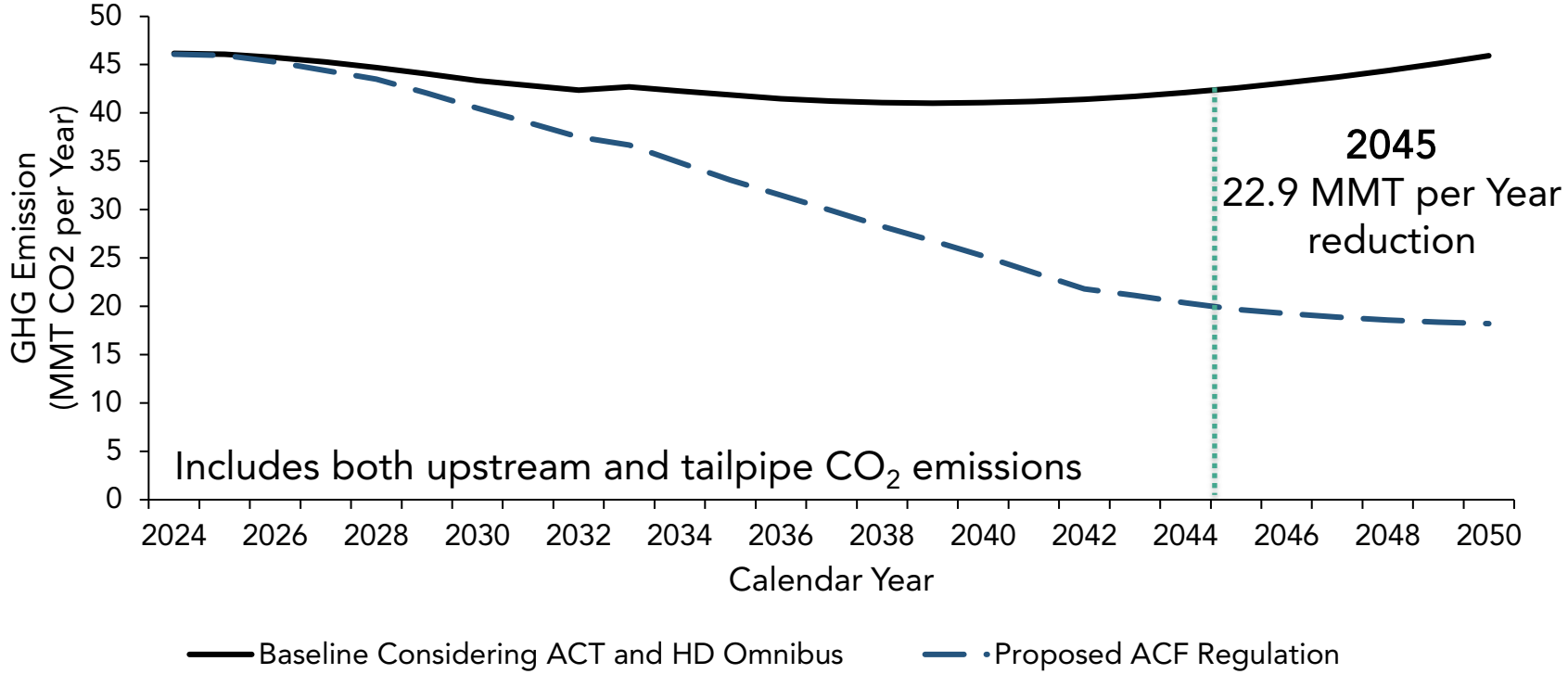
Projected Statewide GHG Emissions



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Next Steps

- Comments requested by September 27, 2021
  - Meeting materials posted on "Meetings and Events" page on CARB's Advanced Clean Fleets webpage
  - Submit comments to informal comment docket (https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=acf-comments-ws&comm_period=1)
- Board recommendation late summer/fall 2022

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Meetings and Events Page (https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-meetings-events)

Advanced Clean Fleets Cost Discussion Document

Today's Outline

- Overview and background
- Cost elements and assumptions
- Total cost of ownership (TCO) results
- Next steps

Total Cost of Ownership Discussion Document

- Draft discussion document to discuss assumptions and key findings
  - Posted August 25, 2021
- Comments requested by September 27, 2021
  - Meeting materials posted on "Meetings and Events" page on CARB's Advanced Clean Fleets webpage
  - Submit comments to informal comment docket (https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=acf-comments-ws&comm_period=1)
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Analysis Overview

- Diesel, gasoline, natural gas, battery-electric, fuel cell electric
- Six body types
  - Class 2b cargo van
  - Class 5 walk-in van
  - Class 6 bucket truck
  - Class 8 refuse packer
  - Class 8 day cab tractor
  - Class 8 sleeper cab tractor
- Analysis performed in 2025, 2030, and 2035

Regulatory Cost Methodology

- Compare costs with regulation to baseline scenario
- Does not include rebates or grants
  - Low Carbon Fuel Standard (LCFS) is a regulation and is included
- Analysis will be in constant dollars without discount rates

Cost Elements

- Vehicle cost
  - Vehicle price
  - Taxes
  - Financing
- Operating Costs
  - Fuel cost
  - DEF Consumption
  - LCFS Revenue
  - Maintenance
  - Midlife costs
  - Registration fees
- Infrastructure
  - EVSE cost
  - Infrastructure upgrades
- Other costs
  - Insurance
  - Depreciation
  - Residual values

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DEF: Diesel exhaust fluid, LCFS: Low Carbon Fuel Standard, EVSE: Electric vehicle supply equipment

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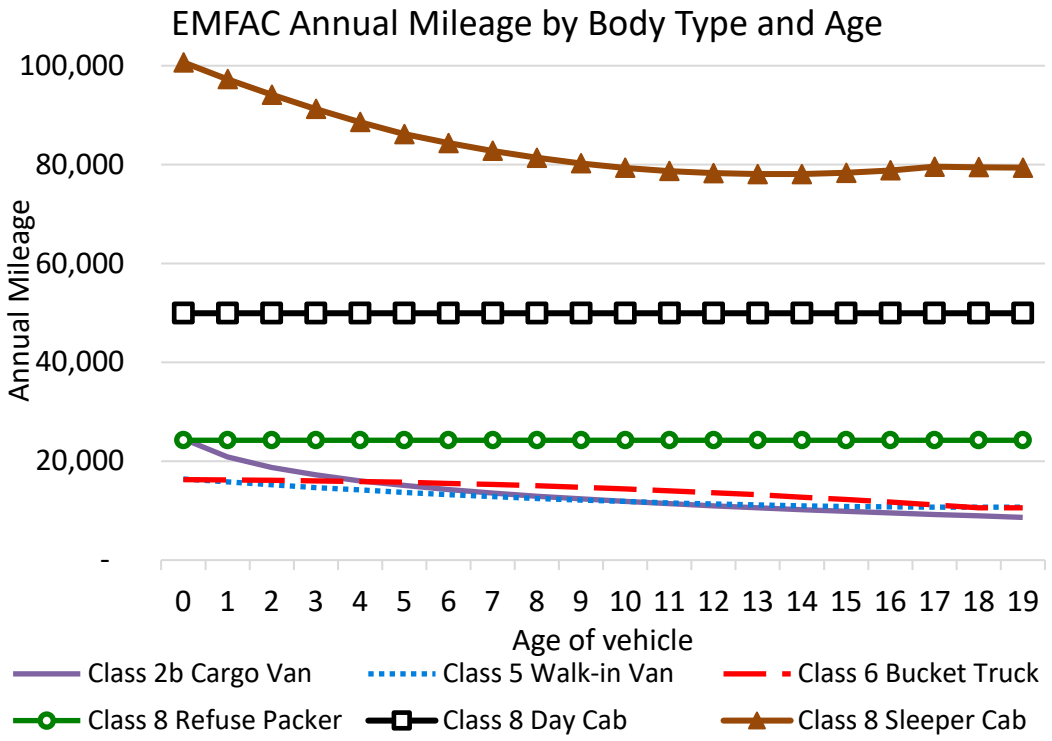
Cost Elements and Assumptions

Vehicle Mileage and Analysis Period

- Mileage assumptions based of EMFAC 2021
- 12-year operating life used in paper
  - Trucks last 15-20 years+

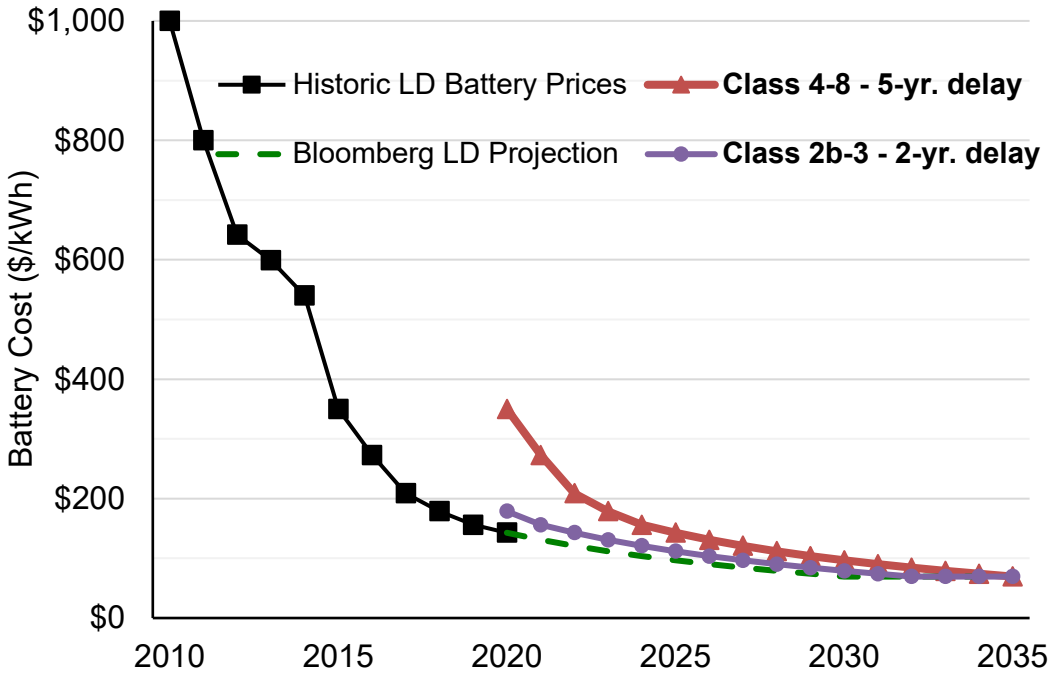


Vehicle Costs

- Gasoline, diesel, and natural gas vehicle cost based on manufacturer websites and truck resale websites
  - Add incremental costs from Phase 2 GHG and Low-NOx Omnibus
- ZEV vehicle cost projections calculated by
  - Determining glider cost
  - Adding ZE component costs
  - An additional cost factor representing R&D, potential profit
  - Additional body costs for vehicles with power takeoff (PTO)

Battery Costs

- Class 4-8 – Bloomberg projections with a five-year delay
- Class 2b-3 – Bloomberg projections with a two-year delay



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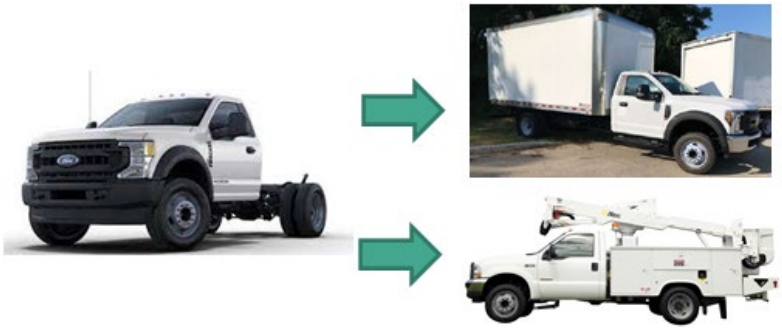
Bloomberg, Better Batteries
https://www.bloomberg.com/quicktake/batteries

Other Component Costs

- Component costs
  - EV components and hydrogen tanks: ICCT "Transitioning to Zero-Emission Heavy-Duty Freight Equipment" https://theicct.org/sites/default/files/publications/Zero-emission-freight-trucks_ICCT-white-paper_26092017_vF.pdf
  - Hydrogen fuel cells: Strategic Analysis, Fuel Cell Systems Analysis https://www.hydrogen.energy.gov/pdfs/review20/fc163_james_2020_o.pdf

Upfit Body Costs

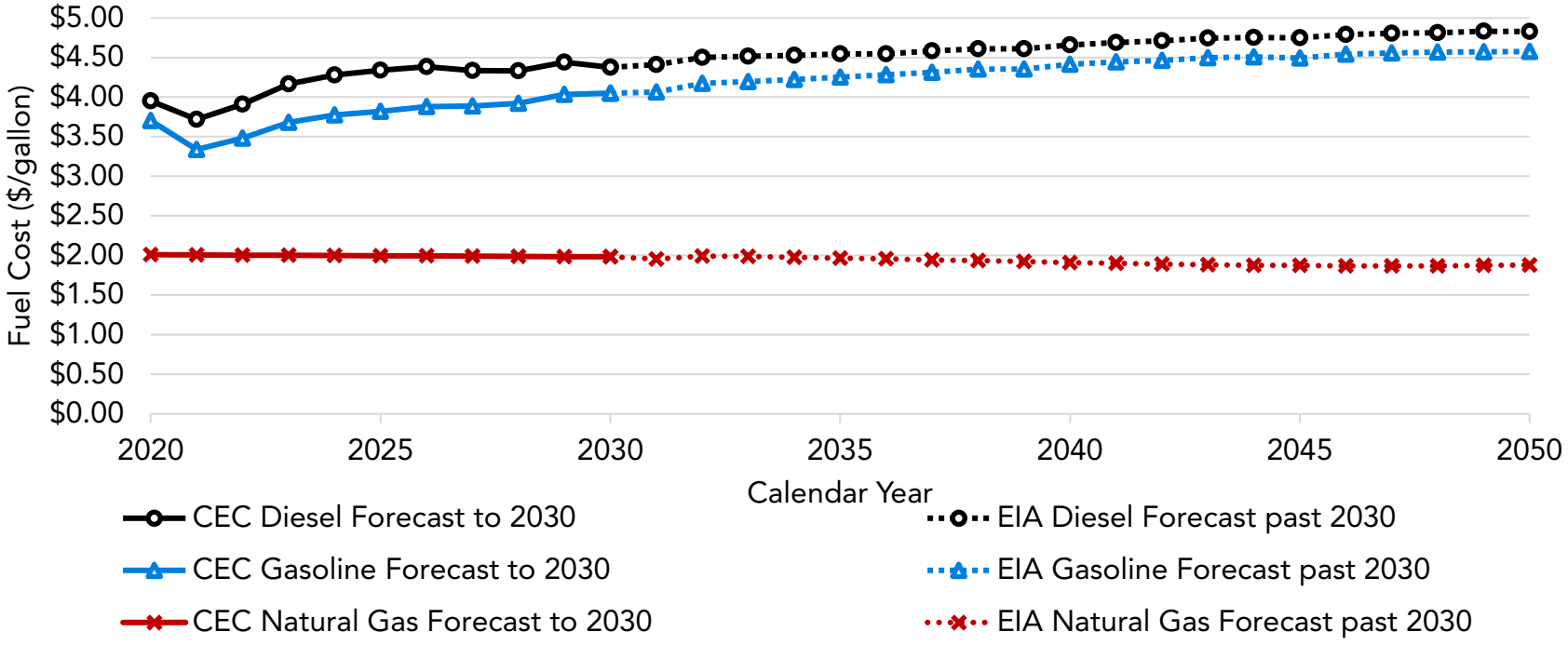
- Cost of installing a body on a chassis depends on the type of vehicle
- Assuming bodies with PTO will have 10% additional body costs until 2030 due to additional engineering



Taxes and Financing

- Taxes
  - Sales tax – statewide average of 8.5%
  - Federal excise tax – 12% for Class 8 vehicles
- Financing
  - Five-year loan at 7%

Fuel Costs – Diesel, Gasoline, and Natural Gas



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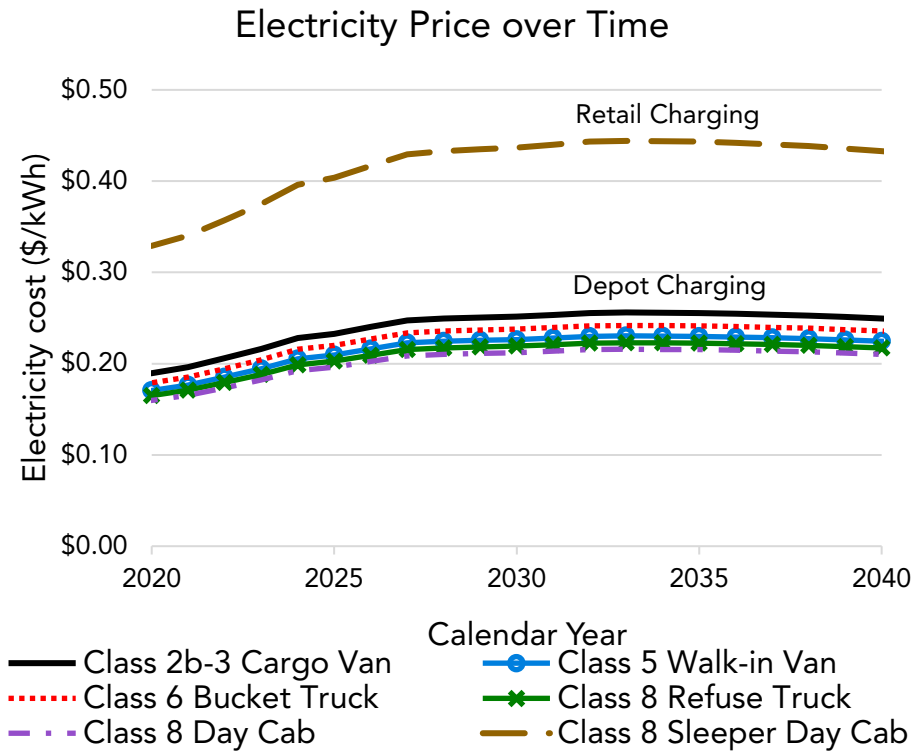
California Energy Commission (CEC) from 2018-2030, high electricity growth
Energy Information Administration (EIA) Pacific Region for 2030+

Fuel Costs - Electricity

- Depot charging – calculate electricity rate using Charging Calculator
- Retail charging – assumed to be $0.31/kWh today similar to prices offered by light-duty fast charging providers
- Assume retail charging for sleeper cabs, depot charging for all others



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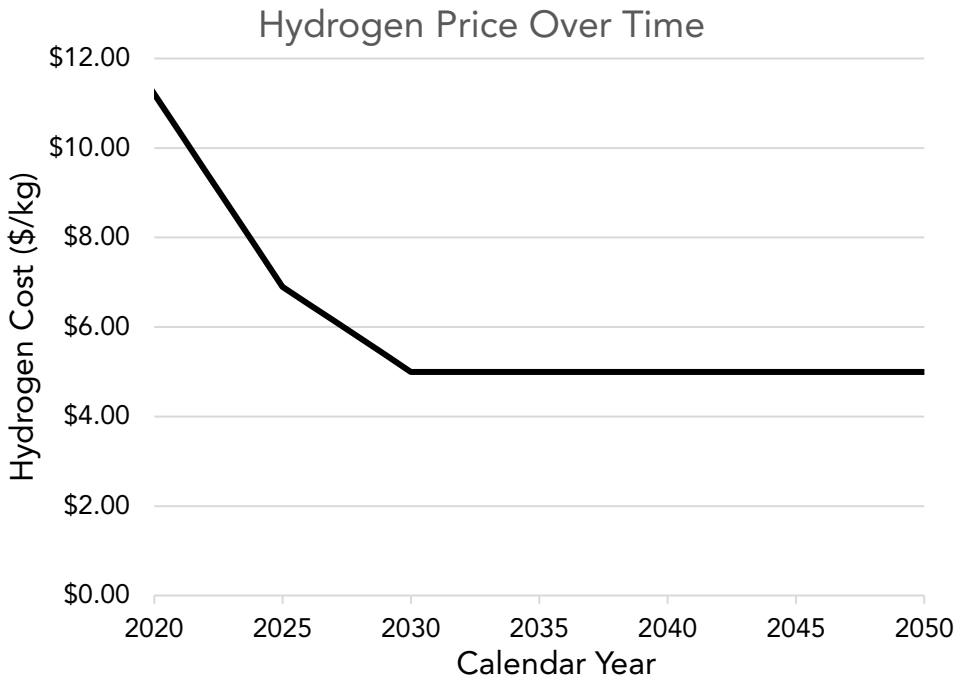
Fuel Costs – Hydrogen

- Hydrogen fuel price
  - Sourced from "Road Map to a US Hydrogen Economy" Report



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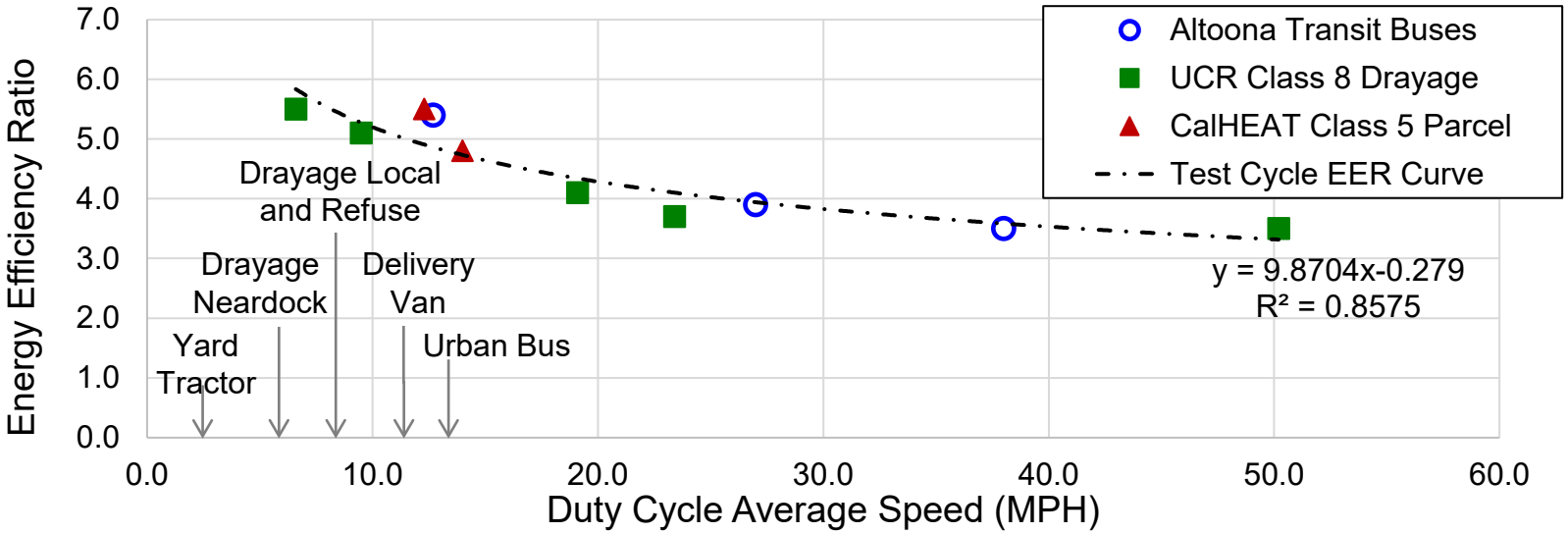
Battery-Electric Vehicle Efficiency

- Battery-electric vehicles have higher efficiency than their diesel counterparts, especially in lower speed applications



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Fuel Efficiency

- Gasoline/diesel/natural gas
  - Based on EMFAC data
- Battery-electric and fuel cell electric
  - Limited in-use data currently
  - Can combine in-use data with values derived from LCFS Energy Economy Ratios
- On page 18-19 in discussion document

Low Carbon Fuel Standard

- The Low Carbon Fuel Standard (LCFS) regulation decreases the carbon intensity (CI) of California's transportation fuels
  - Producers of low carbon fuels such as electricity and hydrogen can generate credits to sell to high carbon fuel producers
- Allows fleets using low carbon fuels to offset their fuel costs
- Credit price assumption
  - $200 until 2030
  - Linear decline to $25 by 2045, and remain there afterwards

LCFS Provides More ZEV Fuel Savings

Electric vs Diesel	Airport Shuttle	Package Delivery	Local Drayage
Assumptions	BEV: 0.6 kWh/mi. Diesel: 22 mpg	BEV: 1.0 kWh/mi. Diesel: 10 mpg	EV: 2.1 kWh/mi. Diesel: 6 mpg
Fuel Savings	40%	50%	40%
Fuel Savings with LCFS	**75%**	**100%**	**100%**

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Note: Example assumes average fuel prices of $3.70/gal., $0.18/kWh (includes transmission, energy, fixed fees, and demand charges), and LCFS credit value at $125 per credit.

Maintenance Cost

- Diesel/gasoline maintenance data based on studies or other in-use information
- 25% maintenance cost reduction for battery-electric and fuel cell electric vehicles
- On page 21-22 in discussion document

Midlife Costs

- Engine rebuilds, battery replacements, fuel cell refurbishments
- Methodology
  - Diesel/gasoline – Engine rebuild at end of useful life, costs 25% of vehicle cost
    - Longer useful life due to Low-NOx Omnibus
  - Battery electric
    - Replacement at 300,000 miles until 2030, then 500,000 miles
    - Cost based on battery size and price at time of replacement
  - Hydrogen fuel cell
    - Refurbishment every 7 years
    - Costs 1/3 of new fuel cell cost at time of refurbishment

Infrastructure Costs

- Gasoline, diesel, hydrogen
  - Infrastructure costs incorporated into fuel price
- Natural gas and battery-electric
  - Assume fleet pays for and installs infrastructure
  - Amortized over 20 years at 7%
  - Some fleets may opt for retail fueling, not currently modeled
- Natural gas infrastructure*
  - Averages $18,000 per Class 4-7 vehicle
  - Averages $40,000 per Class 8 vehicle

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*Assuming 150-200 vehicle deployment

Infrastructure Costs (Cont'd)

- Battery-electric
  - Charger costs from ICCT Report
  - Site infrastructure upgrades based on invoices from 55 projects funded by CARB and others
  - Sleeper cab assumed to use retail charging, no infrastructure cost

Vehicle	Charger Power (kW)	Charger Cost	Infrastructure Upgrade Cost
Class 2b Cargo Van	19	$5,000	$25,000
Class 5 Walk-in Van	19	$5,000	$25,000
Class 6 Bucket Truck	50	$25,000	$44,000
Class 8 Refuse Packer	150 kW for 2 vehicles	$37,500	$44,000
Class 7-8 Day Cab Tractor	150 kW	$75,000	$88,000

International Council on Clean Transportation, Estimating Electric Vehicle Charging Infrastructure Costs Across Major U.S. Metropolitan Areas
https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

Other Cost Elements

- Insurance
  - Physical damage portion is proportional to vehicle price
- Depreciation
- Residual values

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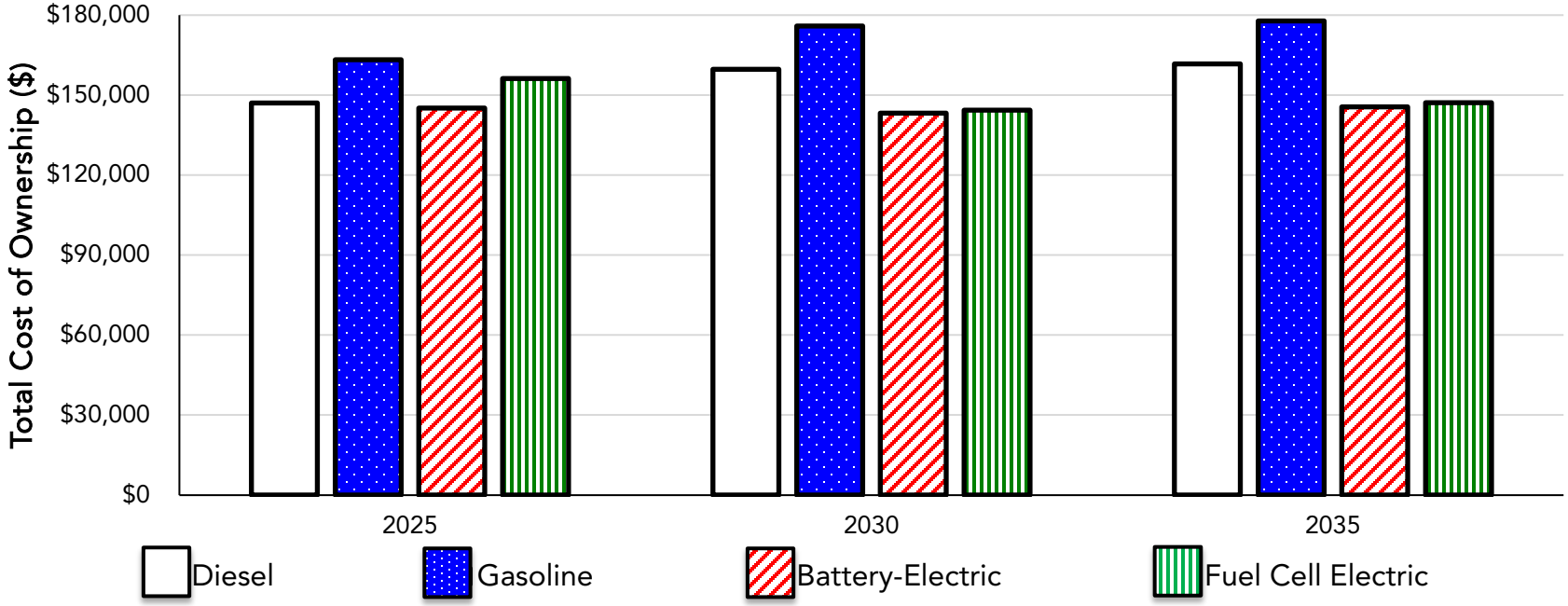
Class 2b Cargo Van TCO



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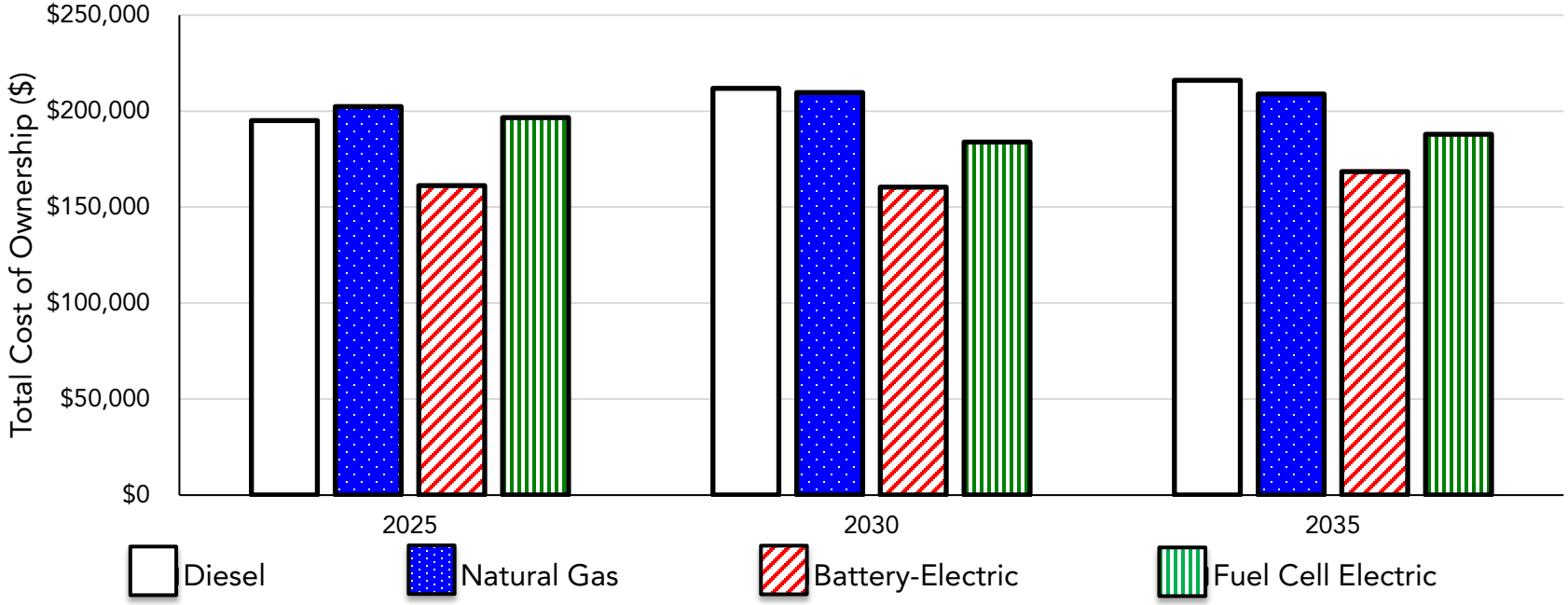
Pages 31-36

CARB Analysis – Class 5 Walk-In Van TCO



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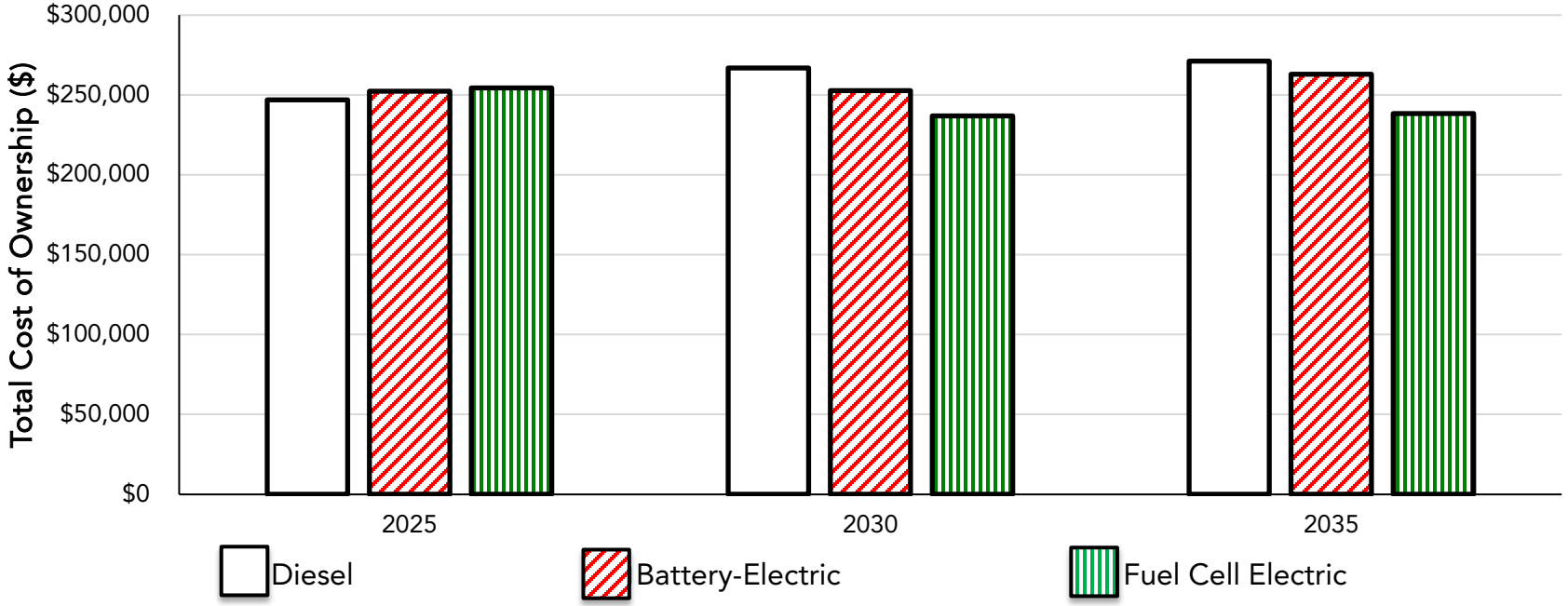
Pages 37-42

CARB Analysis – Class 6 Bucket Truck TCO



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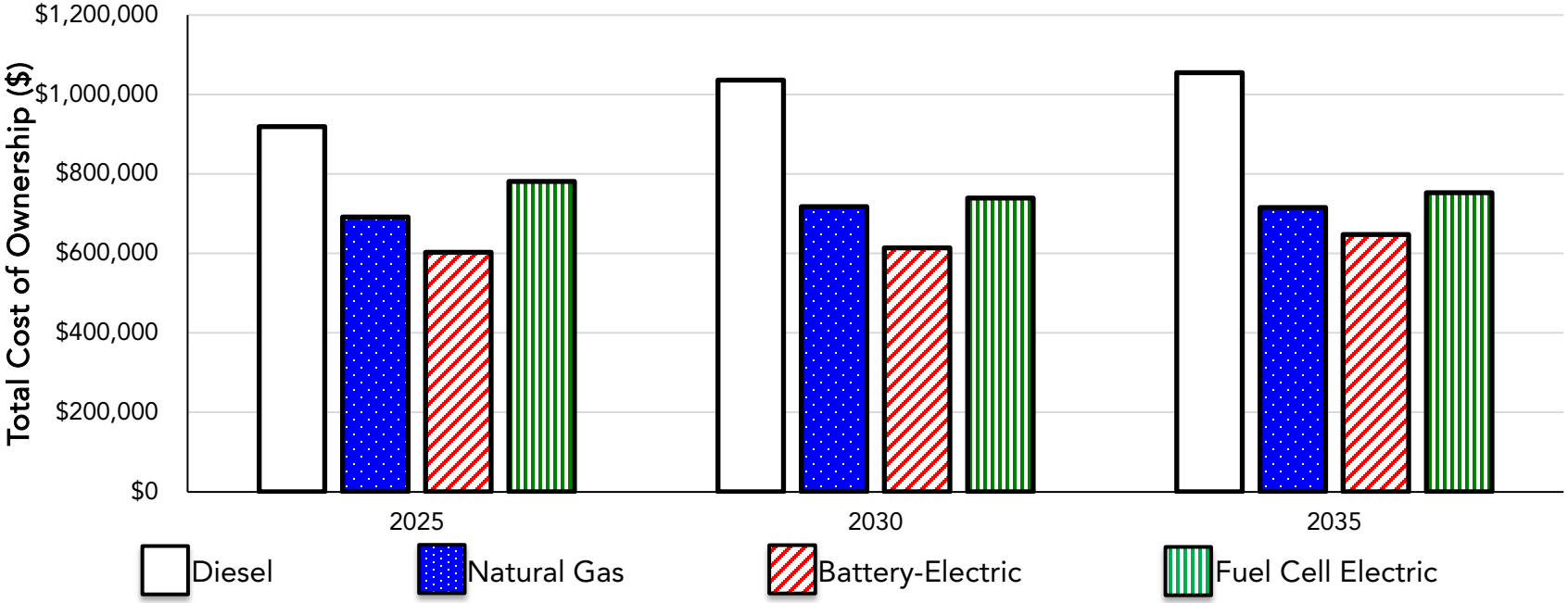
Pages 43-48

CARB Analysis – Class 8 Refuse Packer TCO



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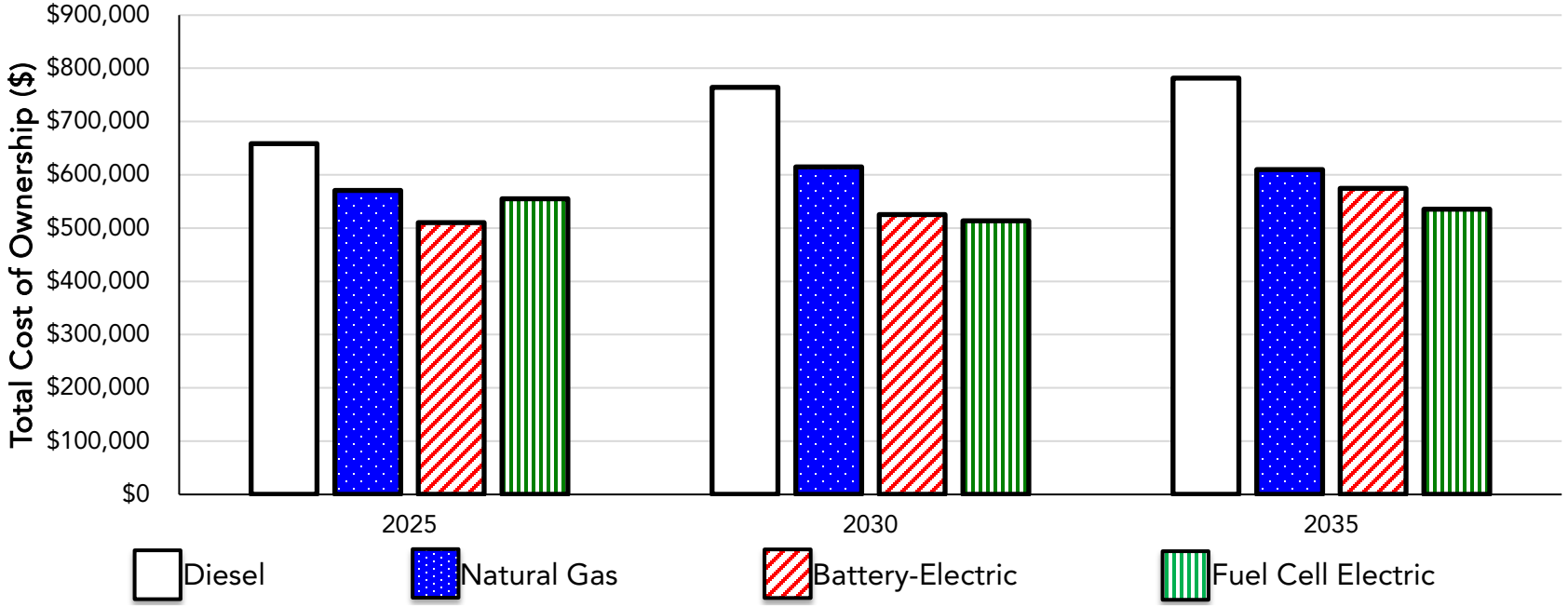
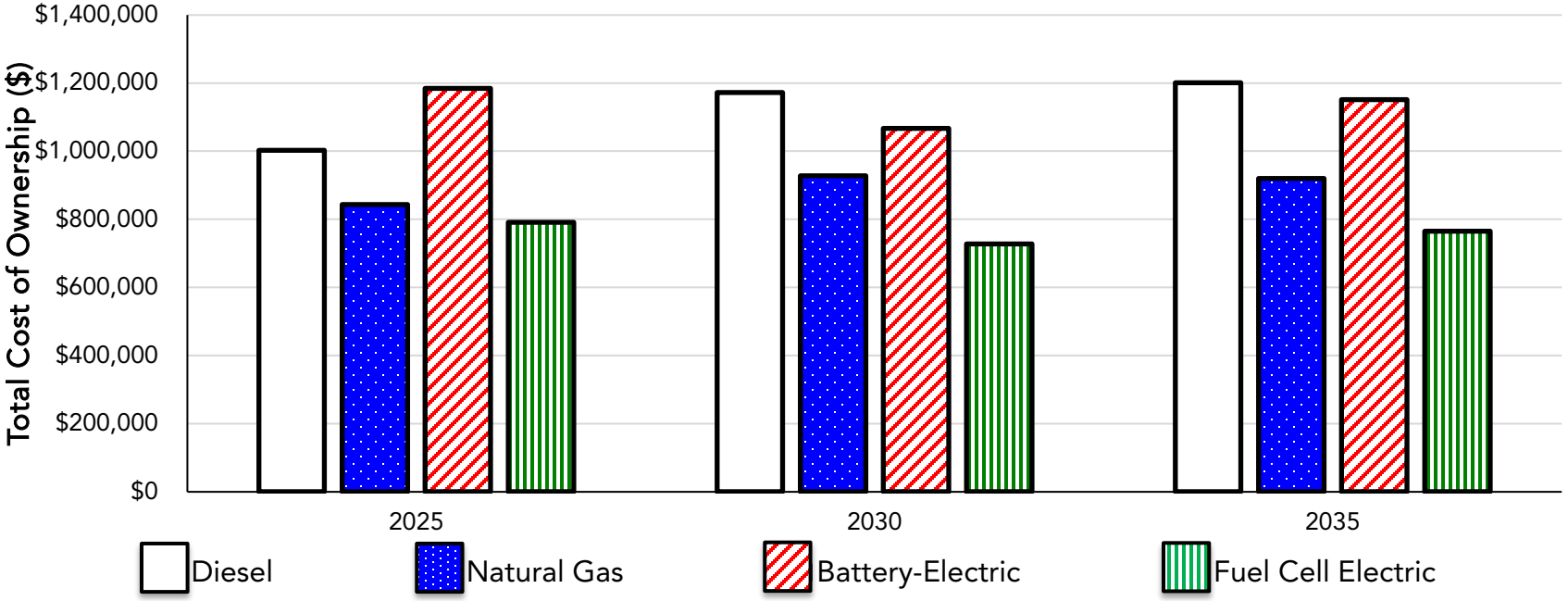
Pages 49-54

CARB Analysis – Class 8 Day Cab Tractor TCO



CARB Analysis – Class 8 Sleeper Cab Tractor TCO



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Pages 61-66

Next steps

- Seeking feedback on cost assumptions
  - Send to zevfleet@arb.ca.gov
- Comments requested by September 27, 2021
  - Meeting materials posted on "Meetings and Events" page on CARB's Advanced Clean Fleets webpage
  - Submit comments to informal comment docket (https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=acf-comments-ws&comm_period=1)

Meetings and Events Page (https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets/advanced-clean-fleets-meetings-events)